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QUANTUM THEORY, INFORMATION AND COSMOLOGY

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v. Weizsäcker has tried to link the terms probability and entropy in terms of information. First there would be an informative movement, not movement-in-matter. Before anything is known, the future is open and events are more or less probable. If an event occurs, a fact has become real and all other probabilities disappear. The modal operators and probabilities of quantum physics require time. With Görnitz, quantum theory determines all spaces of possibility that are closed by knowledge of the world as a manifestation of irreversible time. On the one hand, measurements are gains in information, but on the other hand, possible information also disappears. Following von Weizsäcker, Görnitz understands information as

fundamental to quantum theory, whereby a quantum system only ever possesses a part of the information that is generally available in the universe. With regard to information processing, Gell-Mann distinguishes between fine-grained and coarse-grained worlds/stories. Whether the world appears as a multiple contexture of overlapping worlds or as a coarse grid in which only a few possibilities are permitted or realized is, in quantum theory, among other things, a question of measurement as an information-processing process. Görnitz speaks of meaningless information as a possible environment of meaning that can accept a wealth of possible meaningful information. For v. Weizsäcker, on the other hand, information is only that which is understood, whether by humans or machines. Here, information is neither matter nor consciousness, but a third reality. For von Weizsäcker, it is a form – matter has it and consciousness knows it. Quantum theory would then be the theory of instructing forms, in which potentials are irreversibly transformed into facts in time, and their manifestation in the present in turn opens up scope for new potentialities. Facts are to be understood as events that are based on interactions in a comprehensive present; the present contains the primal alternative or selection, which is not decided deterministically through strict causality, but through observation. Can an observer be found in this observation who can describe himself, who must be transcendental on the one hand and real on the other? In any case, all physical phenomena are now based on a basic position of information theory.

In cybernetic terms, information is about differences that recursively trigger further differences. Shannon defines information positively as a measure of entropy and entropy as a measure of freedom of choice. In contrast to Wiener's definition of information as the negation of entropy, for Shannon more information goes hand in hand with greater uncertainty. A completely predictable message has only one possible outcome and is therefore redundant; it tells us nothing new. Wiener and Shannon arrive at diametrically opposed ideas about what information is, for Wiener defines information as precisely the opposite of information entropy, namely as the negation of entropy. By harmonizing the concept of information with uncertainty and quantifying it as such and without concessions, Shannon arrives at the seemingly paradoxical conclusion that more information means more uncertainty.Shannon's choice to express the unpredictability of the message as "information entropy" (H) reflects the fact that its mathematical formulation in information theory is in fact almost identical to Ludwig Boltzmann's statistical formulation of molecular entropy in thermodynamics (S): Returning to Shannon's formal mathematical definition of information, this means that defining "information entropy" as potential information is a complete reversal: potential would strictly speaking be a negentropic factor that negates entropy. Information entropy is that which is unknown a priori but known a posteriori, and, crucially, the more unknown it is a priori (i.e. the more unexpected it is), the more knowledge it provides a posteriori (i.e. the more it informs us in the traditional sense of the word information). Anticipation. Probability theory thus measures the entropy of information in terms of a progressive relationship between our "freedom of choice" and our ability to predict. This means that the amount of information is never measured only as the content or quantity of the transmitted message, but as a function of the relationship between this message and all possible messages with equivalent constraints. Information is thus understood as a dynamic probability ratio that measures a process rather than a content What Shannon gives us to think about is not an absolute value of noise as novelty – which one could provocatively call

"pure information" if one were to attribute a maximum information value to maximum entropy. Rather, it is the fact that we can now think of information as a more subtle difference than that between organization and chaos or sense and non-sense, a difference that takes place in the conceptual space of entropy, in the space of uncertainty: If information can be thought of as qualified uncertainty, then noise can also be freed from the theoretical exile of negation into which it has been thrown. Noise can become possible information. A quantum system contains one qubit, while composite systems are formed from n elementary systems and carry N bits of information. The basic qubit has a determinate and an indeterminate part, because two properties are entangled in it via the indeterminacy relation. In contrast to a digital and determinate computer, a quantum computer would calculate with indeterminacies and arrive at new unexpected results.

The quantum physicist Thomas Görnitz writes with regard to the creativity of axioms: "An axiomatic structure in mathematics can serve as a model for logical thinking, from which one can then derive the valid laws by logical reasoning. This appears as a deterministic structure, as we know it from classical physics. However, which axioms are chosen is not determined by logic, it is a creative act … The choice of new axioms is reminiscent of the structure in quantum theory, in which the spaces of possible states are multiplicatively linked with each other, so that every building block conception must fail" (Görnitz/Görnitz 2016: 692). As determinations, axioms are also the results of other operations. Mathematics, in turn, provides the possibility of finding forms for phenomena of which we do not yet know what they could physically mean. However, physics must not be understood as purely virtual when it uses imaginary numbers, for example, but must constantly test its results against the resistance of reality,
In his interpretation of quantum theory, Görnitz introduces the concept of protyposis, the essential characteristic of which is a completely abstract, meaningless quantum information that is not localized, has a cosmological dimension and must be imagined without a transmitter and receiver. From the quantum level to the cosmic level, all correlations of events can be described as information processes. For Görnitz, protyposis is the "basic substance" of reality, which can take the form of material particles, energetic quanta and meaningful information. The question is whether it is better to think of meaningless information as virtual. Entropy would then not only be decay, but also order potential information.

The qubits, the elementary entities of protyposis, can be understood as the structural quanta of the cosmos. An infinite number of qubits can be arranged in such a way that they must be interpreted as one quantum particle, as two quantum particles or as many quantum particles. With protyposis, it depends on the degree of precision required and the energy available as to whether it is better to speak of one particle or a particle with a cloud of virtual quanta. If one then postulates that the qubits are actually infinitely many and not just a possibility, then the structures of quantum field theory are also available. For Görnitz, structures are characterized by the information that they are. They can appear actual in connection with a material or energetic carrier. If they bring about something, they acquire a meaning for this process. (Ibid.: 496)

Over decades, Görnitz has developed a cosmological theory of meaningless in-formation, the basic units of which are qubits. A qubit is extremely non-local, whereas a particle is a model

for something localized. Görnitz writes: "A bit only has the states 'yes and no', a qubit has an infinite number of different states. It is true that not every one of these states can be realized with the same probability, some have a high probability, others are unlikely to be obtained, but there are still an infinite number of states. If one then asks whether the state that can be represented by an arrow is present, then only two answers are possible: 'yes, the state is present' or 'no, it is certainly not present' (ibid.: 332). Analogous to the way in which a quantum field can be constructed from an indefinite number of quantum particles, a quantum particle can be generated from an indefinite number of protyposis qubits. It should be emphasized that these can in no way be regarded as particles or objects, since such systems are associated with infinite state spaces. Only at the limit of infinitely many qubits can particles be formed from them. Just as the change of state of a quantum field can be described by adding or removing quantum particles, the change of state of a quantum particle can be understood as an addition or removal of quantum bits. The infinities implied in this have an important consequence. A different arithmetic than the usual one applies to infinity: $\infty = 2 - \infty = 100 - \infty = n - \infty$. Here, "n" should represent an arbitrarily large number.

Görnitz also uses the formula $3 + \infty = \infty$ and $5 + \infty = \infty$ for clarification. This is a completely different addition structure to that of finite numbers, but it is understandable. Infinity makes the finite quantities negligible. From the beginning of the universe, the qubits prove to be a "substance" with a quantum structure for Görnitz. He refers to this as "protyposis", which, ontologically speaking, is still prior to all different types of phenomena, but has the potential for formation. (ibid.: 469ff.) Protyposis is an in-formation structure that is initially meaningless, but can become something meaningful in relation to life. The concept of protyposis also makes it possible to recognize that the basis of existence should rather be understood as a mental structure, even if something material emerges from it. The completely abstract, meaningless quantum information is to be understood as equivalent to matter and energy. Equivalence here stands for "equivalence". Protyposis therefore refers to something that can be converted into matter, energy and ultimately into meaningful information. So if mass, energy and quantum information are equivalent to each other, then it is also possible to attribute something like a quantum of energy to a quantum bit. Matter is a special form of protyposis, namely a form of quantum information that has a mass at rest and can therefore be localized in space and time. Analogous to the different manifestations of H2O, namely ice, water and steam, we find different manifestations of protyposis:

- Matter, which is inert and resists change.
- Energy, which is necessary to set matter in motion and change it.
- Information in the narrower sense, which serves to release available energies.

For Görnitz, matter is a special form of protyposis or a materialization of quantum information, which has a mass at rest and is localized in space and time. Energetic quanta, on the other hand, have no mass at rest and must move in space at the speed of light. If energetic quanta and material quanta can be formed from such an enormous number of qubits, then a wealth of phenomena is possible in the universe. For living beings, the d qubits can become effective as meaningful information, whereby the meaning-bearing qubits can change their carriers. Protyposis, which is connected neither to a material nor to an energetic carrier, is therefore neither here nor now, but always and everywhere, as it were. Quantum theory thus shows that the simplest is also the most extended and not that which is small in space.

The basic cosmological assumption of protyposis is that the number of qubits grows. The increase in protyposis stands for the expansion of the cosmos. The more the number of protyposis qubits grows, the richer structures become possible in the cosmos. The qubits are therefore to be understood as a "pre-structure" that can develop into real structures. These localized structures are initially atoms and black holes, after which stars are formed. The formation of such astrophysical objects and the processes within them are already very well understood by Einstein's theory of gravity and nuclear physics. About a quarter of the protyposis forms local cosmic fluctuations that cannot be meaningfully interpreted as particles, but whose gravitational effect promotes the formation of collections of normal matter – galaxies and galaxy clusters – and influences their behavior. This is the "dark matter". Some of the qubits will occur in identical states, forming highly localized objects. A certain fraction of the protyposis, estimated at around four percent, forms into what we know today as normal matter and light. As already mentioned, there are two types of elementary objects in quantum theory. The first type are elementary particles. With them, the expansion or wavelength decreases with an increase in energy or mass at rest. The famous relation discovered by Max Planck applies to them: the more energetic or massive such an object is, the smaller the corresponding wavelength. The hypothetically most massive elementary particle will therefore have the smallest possible extension, the Planck length of around 10-33 cm. This hypothetical object is also the smallest conceivable object of the second type of elementary objects, the black holes. The characteristic expansion of black holes, the radius of their horizon, grows in proportion to their mass. The more mass they have, the larger they become. The black holes known to astronomers are huge. They can contain up to a million times the mass of the sun.

The tendency today is to treat quantum physical systems more and more as pure carriers of information. Quantum physics is increasingly being transformed into quantum information theory. The physical properties of the carriers of quantum information are often ignored. Only the properties of information processing are of interest. In particular, physical space-time has disappeared from quantum (information) theory. Linear algebra became the most important mathematical tool instead of functional analysis, which played a decisive role in the first 70 years of the development of quantum mechanics. Nowadays, people are no longer so interested in the physical properties of quantum information transformers. Instead, we are looking for other classes of information transformers that are different from quantum physical systems, but which transform information in a quantum-like way. The most basic tool is the quantum probability formalism, the calculus of complex probability amplitudes, equipped with Born's rule, which couples complex amplitudes with probabilities. Another powerful mathematical tool is the use of tensor products to model the (information) behavior of composite systems – a group of transformers interacting with information fields.

Using the information interpretation of quantum field theory, quantum fields can be viewed as quantized information fields. Their quanta, the excitations of the quantum fields, can be interpreted as information quanta. In particular, the electromagnetic quantum field can be treated as a special information field whose quanta are called photons. The spatial wave function of a photon is not precisely defined. Therefore, it cannot be interpreted as a localized physical particle and not as a physical wave. The most consistent way is therefore to treat it as an information quantum given by the momentum and polarization vectors.

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